The following is a complete listing of all claims in the application, with an indication of the status of each:

Listing of claims:

1. (currently amended) A method of managing manufacturing logistics of end products comprising the steps of:

maintaining an inventory of components, which components, termed "building blocks", are built to stock;

configuring-to-order end products using said components; and

replenishing said components from suppliers following a base-stock policy that establishes a base-stock level for each of said components that minimizes a total cost of inventory.

2. (original) The method of managing manufacturing logistics of end products recited in claim 1, wherein the end products are personal computers (PCs) and the components are stock computer components.

3. (original) The method of managing manufacturing logistics of end products recited in claim 1, wherein the base-stock levels are derived from a greedy algorithm which iteratively reduces inventory budget until a budget constraint is satisfied.

4. (currently amended) A computer implemented process of managing manufacturing logistics of configure-to-order end products comprising the steps of:

a) initializing [the] a process of managing manufacturing logistics of configure-to-order end products by setting $x_i := 0$ for each $i \in S$, setting $r_{mi} := P(X_{mi} > 0)$, setting $\beta_m := 0$ for each $m \in M$, and setting $\beta := 0$, where S is a set of components indexed by i, M is a set of end products indexed by m, x_i is [the] a probability of no-stockout of a component of index i, r_{mi} is [the] a probability that a positive number of units of component i is used in the assembly of an end product indexed by m, β_m is [the] a probability of stockout of an end product of index m, and β is [the] an upper limit on the stockout probability over all end products;

b) setting [the] a set of active components to $A := \{\}$;

c) considering each $i \in S$, followed by considering each end product m that uses component i in its bill-of-material;

d) setting $\beta_m := \beta_m + r_{mi}\Delta$, for all m such that $i \in S_m$ where Δ is a unit step size;

e) computing [the] a difference $\delta_i := \max_m\{\beta_m\} - \beta$;

f) determining if $\delta_i \leq 0$, and if so, then adding component index i to the set of active components, $A := A + \{i\}$;

g) determining if the set of active components is non-empty, and if so, then setting $B := A$, otherwise setting $B := S$ where B is a set of component indexes;

h) finding $i^* :=$ [$\arg\max_{i\in B}\{-c_j\sigma_j g'(x_j + \Delta/2)\}$] $\arg\max_{i\in B}\{-c_i\sigma_i/r_{mi}\, g'(x_i + \Delta/2)\}$, where $-g'(\bullet)$ follows the equation

$$-g'(x) = -\Phi(\bar{\Phi}^{-1}(x))\cdot\frac{-1}{\phi(\bar{\Phi}^{-1}(x))} = \frac{1-x}{\phi(\bar{\Phi}^{-1}(x))},$$ where $\Phi(.)$ is [the] a probability distribution function of the standard normal variate, and $\phi(.)$ is [the] a probability density function of the standard normal variate;

i) setting $x_{i^*} := x_{i^*} + \Delta$ to update the probability of no-stockout of component i^*;

j) computing $\beta := \max_{m \in M} \beta_m$, and checking whether inequality $\sum_{i \in S} c_i \sigma_i g(x_i) \leq B$, where B is the budget limit on the expected overall inventory cost, is satisfied and if so, stop and replenish components identified by said set B from suppliers following a base-stock policy that minimizes a total cost of inventory;

k) otherwise, updating β_m and for each $m \in M_{i^*}$, set $\beta_m := \beta_m + r_{mi}\Delta$, and going to step b).

5. (currently amended) A system for managing manufacturing logistics of end products comprising:

means for maintaining an inventory of components, which components, termed "building blocks", are built to stock;

means for configuring-to-order end products using said components; and

means for replenishing said components from suppliers following a base-stock policy that establishes a base-stock level for each of said components that minimizes a total cost of inventory.

6. (original) The system for managing manufacturing logistics of end products recited in claim 5, wherein the end products are personal computers (PCs) and the components are stock computer components.

7. (original) The system for managing manufacturing logistics of end products recited in claim 5, wherein the base-stock levels are derived from a

greedy algorithm which is iteratively computed by a processing unit to reduce inventory budget until a budget constraint is satisfied.

8. (currently amended) A method that translates end-product demand forecast in an assemble-to-order (ATO) environment into a forecast for components, taking into account outbound leadtime comprising the steps of:

defining [the] in an assemble-to-order (ATO) environment an end product demand $D_m(t)$ of type m in period t, each unit of type m demand requiring a subset of components, denoted $S_m \subseteq S$, as

$$D_i(t) = \sum_{m \in M_i} D_m(t + L_m^{\text{out}}); \text{ [and]}$$

deriving mean and variance for component demand $D_i(t)$ as

$$\mathrm{E}[D_i(t)] = \sum_{m \in M_i} \sum_{\ell} \mathrm{E}[D_m(t+\ell)]\mathrm{P}[L_m^{\text{out}} = \ell], \text{ and}$$

$$\begin{aligned}\mathrm{Var}[D_i(t)] = &\sum_{m \in M_i} \sum_{\ell} \mathrm{E}[D_m^2(t+\ell)]\mathrm{P}[L_m^{\text{out}} = \ell] \\ &- \sum_{m \in M_i} \Big(\sum_{\ell} \mathrm{E}[D_m(t+\ell)]\mathrm{P}[L_m^{\text{out}} = \ell] \Big)^2, \text{ respectively; and}\end{aligned}$$

replenishing said components from suppliers following a base stock policy that minimizes a total cost of inventory.

9. (original) The method recited in claim 8, wherein the ATO environment is extended to a configure-to-order (CTO) environment for stationary demand, taking into account batch sizes comprising the steps of:

translating end-product demand into demand for each component i (per period) as

$$D_i = \sum_{m \in M_i} \sum_{k=1}^{D_m} X_{mi}(k).$$

where $X_{mi}(k)$, for $k = 1, 2, \ldots$, are independent, identically distributed (i.i.d.) copies of X_{mi};

deriving marginal distributions, and then the mean and the variance of X_{mi} as

$$\mathrm{E}[D_i] = \sum_{m \in M_i} \mathrm{E}[X_{mi}]\mathrm{E}[D_m], \text{ and}$$

$$\begin{aligned}\mathrm{Var}[D_i] &= \sum_{m \in M_i} \left(\mathrm{E}[D_m]\mathrm{Var}[X_{mi}] + \mathrm{Var}[D_m]\mathrm{E}^2[X_{mi}]\right)\\ &= \sum_{m \in M_i} \left(\mathrm{E}^2[X_{mi}]\mathrm{E}[D_m^2] + \mathrm{Var}[X_{mi}]\mathrm{E}[D_m] - \mathrm{E}^2[X_{mi}]\mathrm{E}^2[D_m]\right), \text{ respectively.}\end{aligned}$$

10. (original) The method recited in claim 9, extended to non-stationary demand, wherein the mean and the variance of X_{mi} are generalized as

$$\mathrm{E}[D_i(t)] = \sum_{m \in M_i} \mathrm{E}[X_{mi}] \sum_{\ell} \mathrm{E}[D_m(t+\ell)]\mathrm{P}[L_m^{\mathrm{out}} = \ell], \text{ and}$$

$$\begin{aligned}\mathrm{Var}[D_i(t)] = &\sum_{m\in M_i} \mathrm{E}^2(X_{mi})\sum_{\ell} \mathrm{E}[D_m^2(t+\ell)]\mathrm{P}[L_m^{\mathrm{out}}=\ell] \\ &+\sum_{m\in M_i} \mathrm{Var}(X_{mi})\sum_{\ell} \mathrm{E}[D_m(t+\ell)]\mathrm{P}[L_m^{\mathrm{out}}=\ell] \\ &-\sum_{m\in M_i} \mathrm{E}^2(X_{mi})\Big(\sum_{\ell} \mathrm{E}[D_m(t+\ell)]\mathrm{P}[L_m^{\mathrm{out}}=\ell]\Big)^2, \text{ respectively.}\end{aligned}$$

11. (original) The method recited in claim 9, further comprising the steps of:

defining $R_i(t)$ as a reorder point (or, base-stock level) in period t as

$$R_i(t) := \mu_i(t) + k_i(t)\sigma_i(t),$$

where $k_i(t)$ is [the] a desired safety factor, while $\mu_i(t)$ and $\sigma_i(t)$ can be derived (via queuing analysis) as

$$\mu_i(t) = \sum_{s=t}^{t+\ell_i^{\mathrm{in}}-1} \mathrm{E}[D_i(s)], \text{ and}$$

$$\sigma_i^2(t) = \sum_{s=t}^{t+\ell_i^{\mathrm{in}}-1} \mathrm{Var}[D_i(s)], \text{ respectively,}$$

where $\ell_i^{\mathrm{in}} := \mathrm{E}[L_i^{\mathrm{in}}]$ is expected in-bound leadtime; and

translating $R_i(t)$ into "days of supply" (DOS), where the $\mu_i(t)$ part of $R_i(t)$ translates into periods of demand and the $k_i(t)\sigma_i(t)$ part of $R_i(t)$ is turned into

$$\frac{k_i(t)\sigma_i(t)}{\frac{\mu_i(t)}{\ell_i^{\text{in}}}}$$

periods of demand so that $R_i(t)$ is expressed in terms of periods of DOS as

$$\text{DOS}_i(t) = \ell_i^{\text{in}}\left[1+k_i(t)\frac{\sigma_i(t)}{\mu_i(t)}\right].$$

12. (original) The method recited in claim 11, wherein demand is stationary in which for each demand class m, $D_m(t)$ is invariant in distribution over time, so that the mean and the variance of demand per period for each component i reduce to

$$\mu_i = \ell_i^{\text{in}}\text{E}[D_i], \text{ and } \sigma_i^2 = \ell_i^{\text{in}}\text{Var}[D_i], \text{ respectively, and}$$

$$R_i = \ell_i^{\text{in}}E[D_i]+k_i\sqrt{\ell_i^{\text{in}}}\,\text{sd}[D_i], \text{ and hence,}$$

$$\text{DOS}_i = \frac{R_i}{\text{E}[D_i]} = \ell_i^{\text{in}}+k_i\theta_i\sqrt{\ell_i^{\text{in}}} = \ell_i^{\text{in}}\left[1+k_i\frac{\theta_i}{\sqrt{\ell_i^{\text{in}}}}\right],$$

where $\theta_i := \mathrm{sd}[D_i]/\mathrm{E}[D_i]$ is the coefficient of variation of the demand *per period* for component *i*, and hence $\theta_i/\sqrt{\ell_i^{\mathrm{in}}}$ is the coefficient of variation of the demand over the leadtime ℓ_i^{in}.

13. (currently amended) A method that relates service requirements to base-stock levels of [the] components in an assemble-to-order (ATO) environment comprising the steps of:

defining <u>in an assemble-to-order (ATO) environment</u> each order of type m as requiring exactly one unit of component $i \in S_m$, α as a required service level, referred to as off-shelf availability of all the components required to configure a unit of type m product, for any m, and E_i as an event that component i is out of stock;

determining a probability P for each end product $m \in M$,

$$\mathrm{P}[\cup_{i \in S_m} E_i] \le 1 - \alpha, \text{ and}$$

$$\mathrm{P}[\cup_{i \in S_m} E_i] = \sum_i \mathrm{P}(E_i) - \sum_{i<j} \mathrm{P}(E_i \cap E_j) + \sum_{i<j<k} \mathrm{P}(E_i \cap E_j \cap E_k) - \cdots, \text{ and}$$

$$\mathrm{P}[\cup_{i \in S_m}] \cong \sum_{i \in S_m} \mathrm{P}(E_i) = \sum_{i \in S_m} \bar{\Phi}(k_i) \le 1 - \alpha \underline{;\ \text{and}}$$

<u>establishing base stock levels for each component i that minimize a total cost of inventory.</u>

14. (currently amended) The method recited in 13, wherein the method is extended to a configure-to-order (CTO) environment taking into account batch sizes, further comprising the steps of:

defining $A \subseteq S_m$ as a certain configuration, which occurs in a demand stream with probability P(A);

weighting a no-stockout probability, $\prod_{i \in A} \Phi(k_i)$, by P($A$);

changing the service requirement to

$$\begin{aligned}
\alpha &\leq \sum_{A \subseteq S_m} \mathrm{P}(A) \prod_{i \in A} \Phi(k_i) \\
&\approx \sum_{A \subseteq S_m} \mathrm{P}(A) \left[1 - \sum_{i \in A} \bar{\Phi}(k_i)\right] \\
&= 1 - \sum_{A \subseteq S_m} \mathrm{P}(A) \sum_{i \in A} \bar{\Phi}(k_i) \\
&= 1 - \sum_{i \in S_m} \left(\sum_{i \in A} \mathrm{P}(A) \right) \bar{\Phi}(k_i); \text{ and}
\end{aligned}$$

extending the CTO environment the service requirement to

$$\sum_{i \in S_m} r_{mi} \bar{\Phi}(k_i) \leq 1 - \alpha$$

where r_{mi} is the probability that a positive number of units of component i is used in the assembly of an end product indexed by m.

15. (currently amended) A method that translates service requirements in terms of leadtimes into requirements for [the] off-shelf availability of [the] components comprising the steps of:

relating an off-shelf availability requirement to standard customer service requirements expressed in terms of leadtimes, W_m, where a required service level of type m demand is

$$P[W_m \leq w_m] \geq \alpha, \quad m \in M,$$

where w_m's are given data and P is probability;

when there is no stockout at any store $i \in S_m$, denoting the associated probability as $\pi_{0m}(t)$, a delay being L_i^{out}, the out-bound leadtime;

when there is a stockout at one or several stores in the subset $s \subseteq S_m$, denoting the associated probability as $\pi s_m(t)$, so that the delay becomes $L_i^{out} + \tau_s$, where τ_s is the additional delay before the missing components in s become available;

determining $P[W_m \leq w_m] = \pi_{0m}(t)P[L_m^{out} \leq w_m] + \sum_{s \in S_m} \pi_{sm}(t)P[L_m^{out} + \tau_s \leq w_m]$;

[and]

assuming that

$$L_m^{out} \leq w_m \quad \text{and} \quad L_m^{out} + \tau_s > w_m$$

both hold *almost surely*, so that when the (nominal) outbound leadtime is nearly deterministic and shorter than what customers require, whereas the replenish leadtime for any component is substantially longer; and

replenishing said components from suppliers following a base stock policy that minimizes a total cost of inventory.